WHAT WE CLAIM ARE:

1. A method of manufacturing a solid state imaging device, comprising:

(a) forming photosensors, disposed on a semiconductor substrate in a matrix shape, for photoelectrically converting incident light into signal charges, and forming a light shielding film above said photosensors, said light shielding film having openings and increasing a height from a surface of the semiconductor substrate near the openings;

(b) forming a first insulating layer on the semiconductor substrate, said first insulating layer covering said light shielding film and being made of additive-containing silicon oxide;

(c) reflowing said first insulating layer to form downward convex curved surfaces;

(d) forming upward and downward convex inner lenses on said reflowed first insulating layer above the openings, said inner lens being made of silicon nitride;

(e) forming a second insulating layer covering said inner lenses, said second insulating layer having a planarized surface and being made of silicon oxide based insulator;

(f) forming color filters on the planarized surface of said second insulating layer;

(g) forming a planarizing layer of transparent material covering said color filters;

(h) forming micro lenses on said planarizing layer; and

(i) forming a low refractive index layer covering said micro lenses, said low refractive index layer having a refractive index lower than a refractive

index of said micro lens.

2. The method of manufacturing a solid state imaging device according to claim 1, wherein the additive-containing silicon oxide used in said step (b) is BPSG.

3. The method of manufacturing a solid state imaging device according to claim 1, wherein said step (a) forms said photosensors by forming a p-type well in an n-type semiconductor substrate and forming a plurality of n-type regions in said p-type well.

4. The method of manufacturing a solid state imaging device according to claim 3, wherein said step (a) forms a vertical channel adjacent to each column of said photosensors and a plurality of transfer electrodes above said semiconductor substrate, said transfer electrodes alternately covering said vertical channels and extending in a direction crossing said vertical channels.

5. The method of manufacturing a solid state imaging device according to claim 1, wherein said step (d) comprises:

(d1) depositing a first silicon nitride film on said reflowed first insulating layer by chemical vapor deposition;

(d2) planarizing a surface of said first silicon nitride film and forming lower convex lenses;

(d3) depositing a second silicon nitride film above said semiconductor substrate by chemical vapor deposition, said second silicon nitride film covering said lower convex lenses; and

(d4) forming upper convex lenses by etching said second silicon nitride film by using a mask having a lens pattern.

6. The method of manufacturing a solid state imaging device according to claim 5, wherein said step (d2) etches back said first silicon nitride film.

7. The method of manufacturing a solid state imaging device according to claim 5, wherein said step (d2) chemical-mechanical-polishing said silicon nitride film.

8. The method of manufacturing a solid state imaging device according to claim 5, wherein said step (d4) comprises steps of:

forming a resist pattern having plan shapes of said upper convex lenses to be formed on said second silicon nitride film; and

heating and softening said resist pattern to make said upper convex lenses have a spherical surface.

9. The method of manufacturing a solid state imaging device according to claim 5, wherein said silicon oxide based insulator used in said step (e) is BPSG.

10. The method of manufacturing a solid state imaging device according to claim 5, wherein said step (h) comprises steps of:

forming a resist pattern having plan shapes of said micro lenses to be formed on said planarizing layer; and

heating and softening said resist pattern to make said micro lenses have a spherical surface.

11. The method of manufacturing a solid state imaging device according to claim 10, wherein in said step (h) said micro lenses are formed to have a thickness of 0.5 μm or thinner.

12. The method of manufacturing a solid state imaging device according to claim 1, further comprising a step of disposing a transparent plate on said low refractive index layer.

13. The method of manufacturing a solid state imaging device according to claim 12, further comprising a step of disposing a back insulating plate on an adhesive layer formed on a bottom surface of said semiconductor substrate.

14. The method of manufacturing a solid state imaging device according to claim 13, further comprising forming leads extending from said semiconductor substrate to said back insulating plate.

15. A method of manufacturing a solid state imaging device, comprising steps of:

(a) forming a semiconductor structure having: photosensors disposed in and above a semiconductor substrate in a matrix shape, the photosensors photoelectrically converting incident light into signal charges; vertical CCDs for transferring the signal charges generated in the photosensors in a vertical direction; a horizontal CCD for transferring the signal charges supplied from the vertical CCDs in a horizontal direction; and a light shielding film

having openings above the photosensors;

(b) forming a first insulating layer on said semiconductor structure, said first insulating layer being made of additive-containing silicon oxide;

(c) reflowing said first insulating layer and forming upward and downward convex inner lenses on said reflowed first insulating layer and above the photosensors, said inner lenses being made of silicon nitride;

(d) forming a second insulating layer covering said inner lenses and made of silicon oxide based insulator;

(e) planarizing an upper surface of said second insulating layer;

(f) forming color filters on the planarized upper surface of said second insulating layer;

(g) forming a transparent flat layer covering said color filters, said transparent flat layer being made of transparent material;

(h) forming micro lenses on said transparent flat layer;

(i) forming a low refractive index layer covering said micro lenses, said low refractive index layer having a refractive index lower than a refractive index of said micro lenses;

(j) disposing a transparent plate on said low refractive index layer; and

(k) packaging said semiconductor structure disposed with said transparent plate.

16. A solid state imaging device comprising:

a semiconductor substrate having: photosensors disposed in a matrix shape for photoelectrically converting incident light into signal charges;

vertical transfer channels for transferring the signal charges generated in the photosensors in a vertical direction; and a horizontal transfer channel for transferring the signal charges supplied from the vertical transfer channels in a horizontal direction;

first and second electrodes formed above the vertical transfer channels and extending in a direction crossing the vertical transfer channels;

a light shielding film formed above said first and second electrodes ;

upward and downward convex inner lenses made of silicon nitride, at the height level above said photosensors and at a process level after forming said light shielding film;

micro lenses formed above said inner lenses;

a low refractive index layer covering said micro lenses, said low refractive index layer having a refractive index lower than a refractive index of said micro lenses; and

a transparent plate disposed on said low refractive index layer.

17. The solid state imaging device according to claim 16, wherein a thickness of said micro lens is 0.5 μm or thinner.

18. The solid state imaging device according to claim 16, further comprising a plurality of leads connected to said semiconductor substrate.

19. The solid state imaging device according to claim 18, further comprising an insulating protection plate adhered to a bottom surface of said semiconductor

substrate.

20. The solid state imaging device according to claim 16, wherein said inner lens includes a downward convex lens area and an upward convex lens area.

21. The solid state imaging device according to claim 20, wherein said upward convex area has a plan shape broader than said downward convex lens area.

22. The solid state imaging device according to claim 20, wherein said light shielding film increases a height thereof from a surface of said semiconductor substrate near the openings, and said inner lens is formed inside an area where the height of said light shielding film increases.